

mined that human affects to park ecosystems needed to be more explicitly included in our models than they had been to date (see discussion in Chapter 2). As a result the Ecological Footing of “Near-field Human Drivers” was added to our conceptual model. We determined an initial list of vital signs under this footing and potential measures, however those vital signs have not yet been prioritized. During this meeting we were also able to appropriately link some vital signs that had been listed separately. However, the Technical Committee will continue to work on the list of vital signs and their measures. We recognize that there still remain some “apples and oranges” in our list of vital signs. Further definition of the proposed Vital Signs will help resolve this problem.

The next steps in the selection and prioritization process are further discussion and refinement of the initial Vital Signs list by the Technical Committee and Board of Directors, and then selection of the final list. These steps will occur during the first quarter of FY 2004. The Technical Committee is meeting October 1-2, 2003, to discuss the Vital Signs and review the prioritization process used thus far. The Board of Directors has also reserved time for further discussion and consideration of the Vital Signs. Each Superintendent will meet with their park’s staff to ensure that the network Vital Signs will meet their park’s needs. The Board will then reconvene and provide formal guidance to the Network Coordinator and Technical Committee about the Vital Signs and program direction.

3.2 Proposed Vital Signs

The initial prioritized list of proposed Vital Signs for the Central Alaska Network includes 36 Vital Signs (Table 6). These include 9 related to Physical Drivers, 9 related to Vegetation, 5 related to Habitat, 5 related to Fauna, and 8 related to Near-field Human Drivers. These Vital Signs and their rankings, with the exception of the Near-field Human Drivers, were derived based on the process described in the previous section.

Table 6. Initial prioritized list of Proposed Vital Signs for the Central Alaska Network.

Ecological Footing and Rank	Proposed Vital Sign	Potential Measures
<i>Physical Drivers</i>		
1	Climate/Weather	Temperature, precipitation, wind
2	Snowpack	Total accumulation, timing, geographic extent
3	Water quality – ponds & streams	pH, conductivity, total N, total P, turbidity,
4	temperature, alkalinity	
5	Permafrost	Active layer depth, presence/absence
6	Disturbance regime	Fire frequency/intensity, wind, tectonics, geomorphology, volcanism
7	Ice phenology	On/off timing
8	River/stream flow	Flow rate, timing
9	Glaciers	Mass balance, movement
	Air quality	Measures of existing NPS program

Table 6. Initial prioritized list of Proposed Vital Signs, continued.

<i>Vegetative Characteristics</i>		
1	Structure/Compostion	Cover by growth form class & species (aquatic/terrestrial), species and species area relationships
2	Plant phenology	Timing of leaf out
3	Fuels	Type, size and position and fuels
4	Pond primary production	Littoral vegetation extent/classification, species relative abundance, chlorophyll a
5	Density/basal area of whitespruce	Selected species at landscape scale
6	Special communities	Subarctic steppe communities, distribution and abundance of lichens, sensitive species and exotic plants
7	Chronosequences	Structure and composition
8	Stream vegetation	Riparian vegetation classification, percent overhead cover
9	Whitespruce growth/reproduction	Seed production, diameter breast height
<i>Habitat Patterns</i>		
1	Landcover change	Percent of land in specified categories, distribution of landcover types (including water bodies)
2	Pond characteristics	Distribution/abundance of ponds
3	Landscape appearance	Photograph points
4	Stream characteristics	Channel course maps, extent of pool/riffle habitat, channel width/depth, bed stability
5	Anecdotal observations	
<i>Fauna Characteristics</i>		
1	Animal distribution patterns	Presence/absence of selected species, geographic extent
2	Stream animals	Fish species richness, fish community composition, fish density/relative abundance
3	Pond animal productivity	Macroinvertebrate density, plankton composition, zooplankton density
4	Human presence	Presence/absence of human sign
5	Forage quality	Carbon:nitrogen
6	Insect damage	Presence/absence of insect damage in plots
<i>Near-field Human Drivers</i>		
1 ¹	Consumptive use	Annual harvest of wildlife/fish, firewood, home logs, gravel
2 ¹	Park resident and adjacent populations	Abundance estimate
3 ¹	Human presence	Presence/absence of human sign
4 ¹	Sound quality	Decibel level
5 ¹	Water use (ground and surface)	Annual rate of use
6 ¹	Trails (hiking/ATV), airstrips, snowmobiles	Number of miles of trails, number of airstrips, metric of snowmobile use
7 ¹	Potential concerns	Number of ships in Icy Bay, RS2477 circumstances, navigable rivers, new roads
8 ¹	Recreational visitor use	Number of visitors, campsite impacts

¹ The vital signs under this Ecological Footing have not yet been ranked by the CAKN Technical Committee.

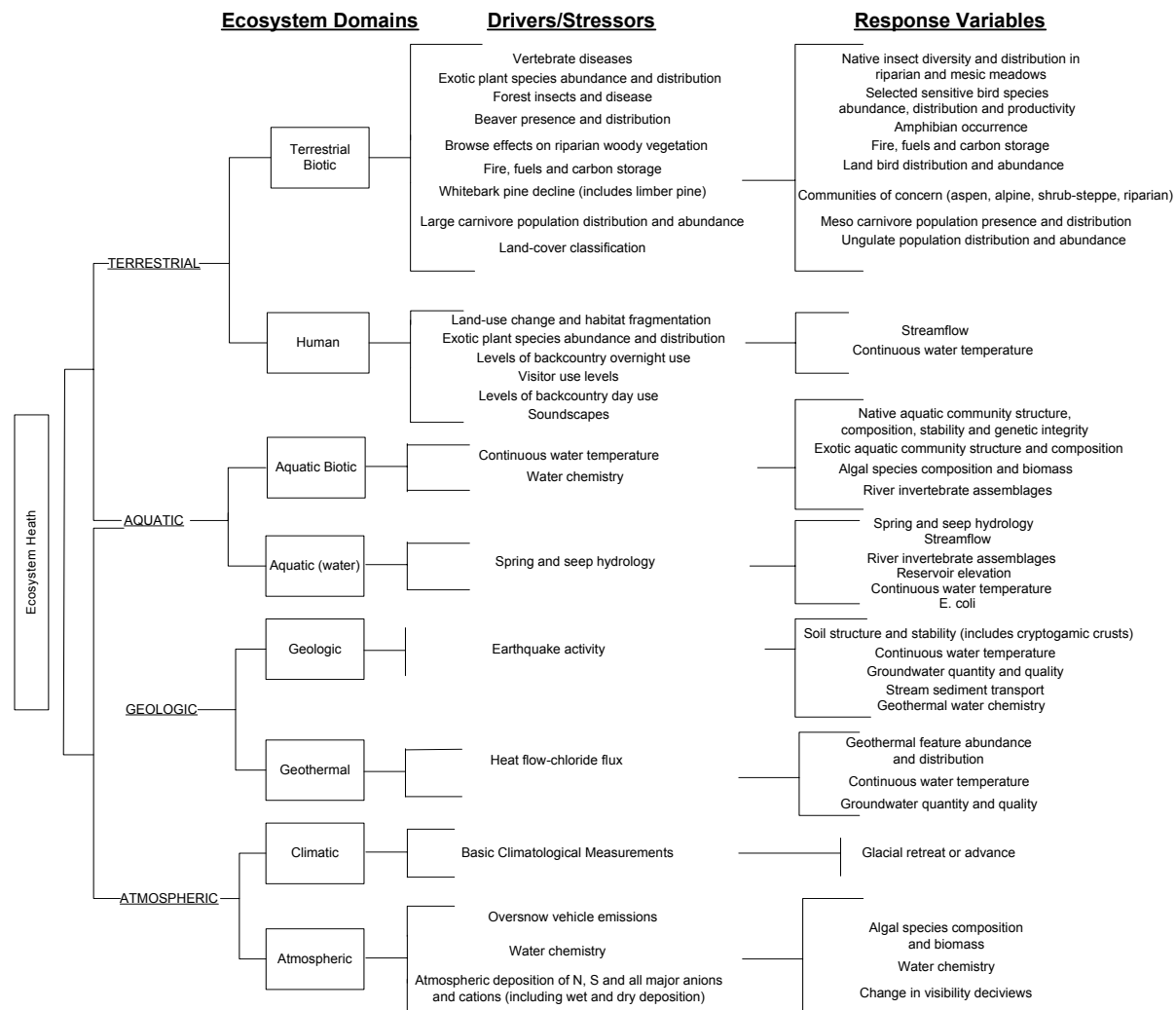


Figure III.3: Conceptual framework showing the TC's recommended 44 vital signs for the GRYN.

Table III.5: Phase II vital signs selected for the Greater Yellowstone Network. These vital signs, shown underlined and as categorized by the SC, will be carried forward into Phase III. Several vital signs have had minor name modifications since the TC selection (Table III.3). The SC recommended "below ground biota and processes" as a vital sign, plus separated groundwater into two vital signs—quantity and quality—resulting in the Network's final list of 46 vital signs. Prioritization for Network monitoring can be found in Table III.3.

Physical/Chemical Environment	Biotic Environment
<p>1. Physical climate</p> <p><u>a. Basic climatological measurements</u></p> <p><u>b. Glacial retreat or advance</u></p> <p>2. Hydrology</p> <p><u>a. Watershed budgets</u></p> <p><i>i. Stream flow</i></p> <p><i>ii. Groundwater quantity</i></p> <p><i>iii. Springs and seeps distribution and hydrology</i></p> <p><i>iv. Reservoir elevation</i></p> <p>3. Water Quality</p> <p><u>a. Water chemistry</u></p> <p><u>b. Groundwater quality</u></p> <p><u>c. <i>E.coli</i> (<i>Escherichia coli</i>)</u></p> <p><u>d. Continuous water temperature</u></p> <p><u>e. Stream sediment transport</u></p> <p>4. Geology</p> <p><u>a. Geothermal</u></p> <p><i>i. Heat flow/ chloride flux</i></p> <p><i>ii. Geothermal feature abundance and distribution</i></p> <p><i>iii. Geothermal water chemistry</i></p> <p><u>b. Earthquake activity</u></p> <p>5. Chemical climate</p> <p><u>a. Atmospheric deposition of all major anions and cations</u></p> <p><u>b. Change in visibility</u></p> <p><u>c. Oversnow vehicle emissions</u></p>	<p>1. Terrestrial Ecosystem</p> <p><u>a. Vegetation Dynamics</u></p> <p><i>i. Landscape</i></p> <p><u>1. Land-cover classification</u></p> <p><u>2. Fire, fuels and carbon storage</u></p> <p><i>ii. Community</i></p> <p><u>1. Communities of concern (aspen, riparian, shrub-steppe, and alpine)</u></p> <p><u>2. Browse effects on riparian vegetation</u></p> <p><i>iii. Populations</i></p> <p><u>vi. Whitebark pine decline</u></p> <p><u>vii. Forest insect and disease of concern</u></p> <p><u>viii. Exotic plant species abundance and distribution</u></p> <p><u>b. Above-ground consumers</u></p> <p><i>i. Vertebrate dynamics</i></p> <p><u>1. Birds</u></p> <p><i>a. Land bird distribution and abundance</i></p> <p><i>b. Selected sensitive bird species abundance, distribution and productivity</i></p> <p><u>2. Amphibian occurrence</u></p> <p><u>3. Mammals</u></p> <p><i>a. Ungulate population distribution and distribution</i></p> <p><i>b. Beaver presence and distribution</i></p> <p><i>c. Large carnivore population distribution and abundance</i></p> <p><i>d. Meso-carnivore population</i></p> <p><u>4. Vertebrate disease (native and exotic)</u></p> <p><i>ii. Invertebrates</i></p> <p><u>1. Native insect diversity and distribution in riparian and mesic meadows</u></p> <p><u>c. Ground surface and subsurface ecosystems</u></p> <p><i>i. Soil structure and stability</i></p> <p><i>ii. Belowground biota and processes</i></p> <p>2. Aquatic Ecosystem</p> <p><u>a. Primary producers</u></p> <p><i>i. Algal species composition and biomass</i></p> <p><u>b. Consumers</u></p> <p><i>i. Native aquatic community structure and composition</i></p> <p><i>ii. River invertebrate assemblages</i></p> <p><i>iii. Exotic aquatic community structure and composition</i></p>
Human Dimensions	
<p>1. Human Use</p> <p><u>a. Levels, types and distribution of visitor use</u></p> <p><i>i. Levels of backcountry day use</i></p> <p><i>ii. Levels of backcountry overnight use</i></p> <p><u>b. Soundscapes</u></p> <p><u>c. Land-use change</u></p>	

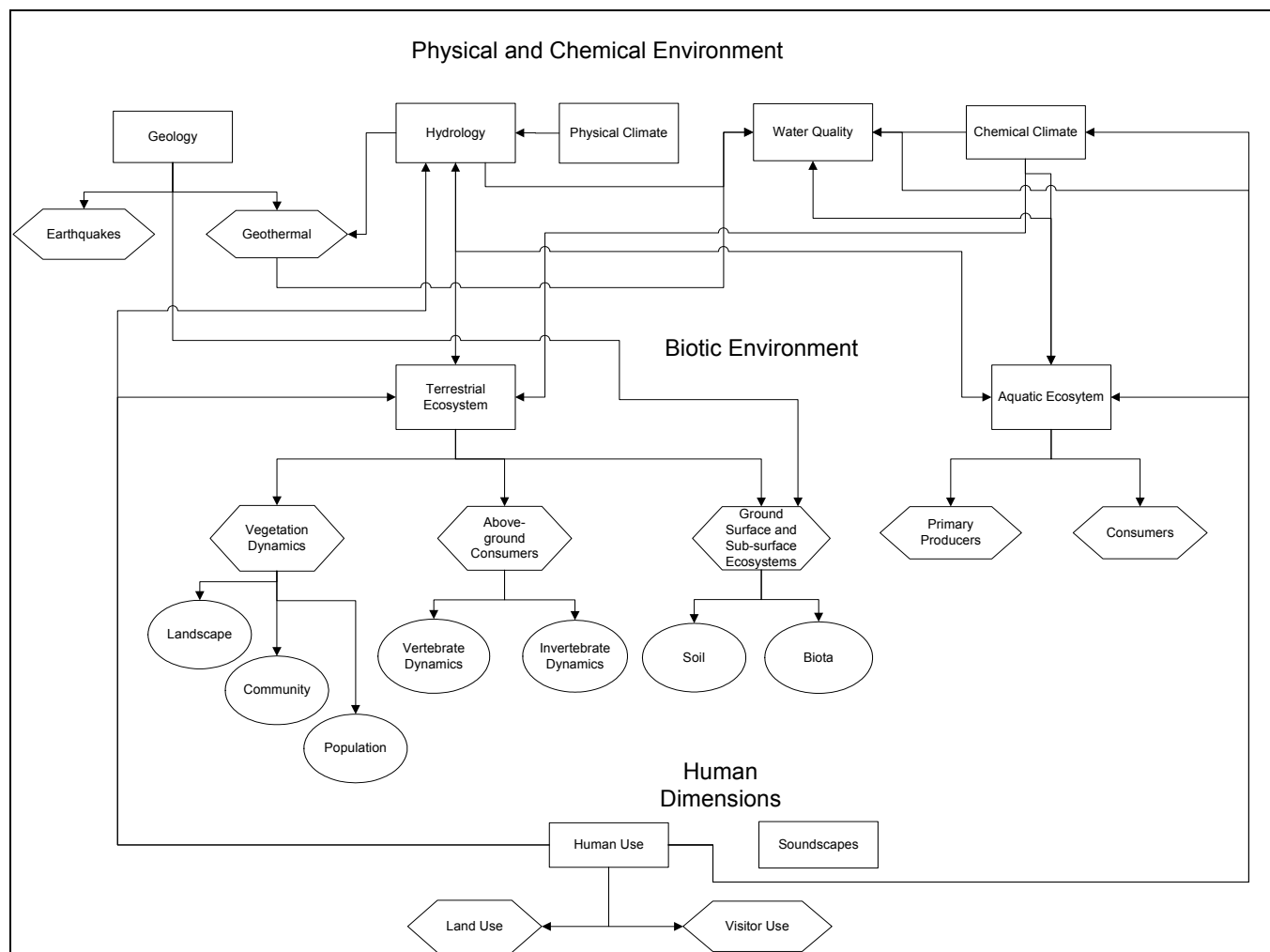


Figure III.5: Interrelationships among vital sign categories. Integration of vital signs showing linkages among categories of vital signs within physical and chemical, biological, and human groupings (see Table III.5 for category hierarchy).

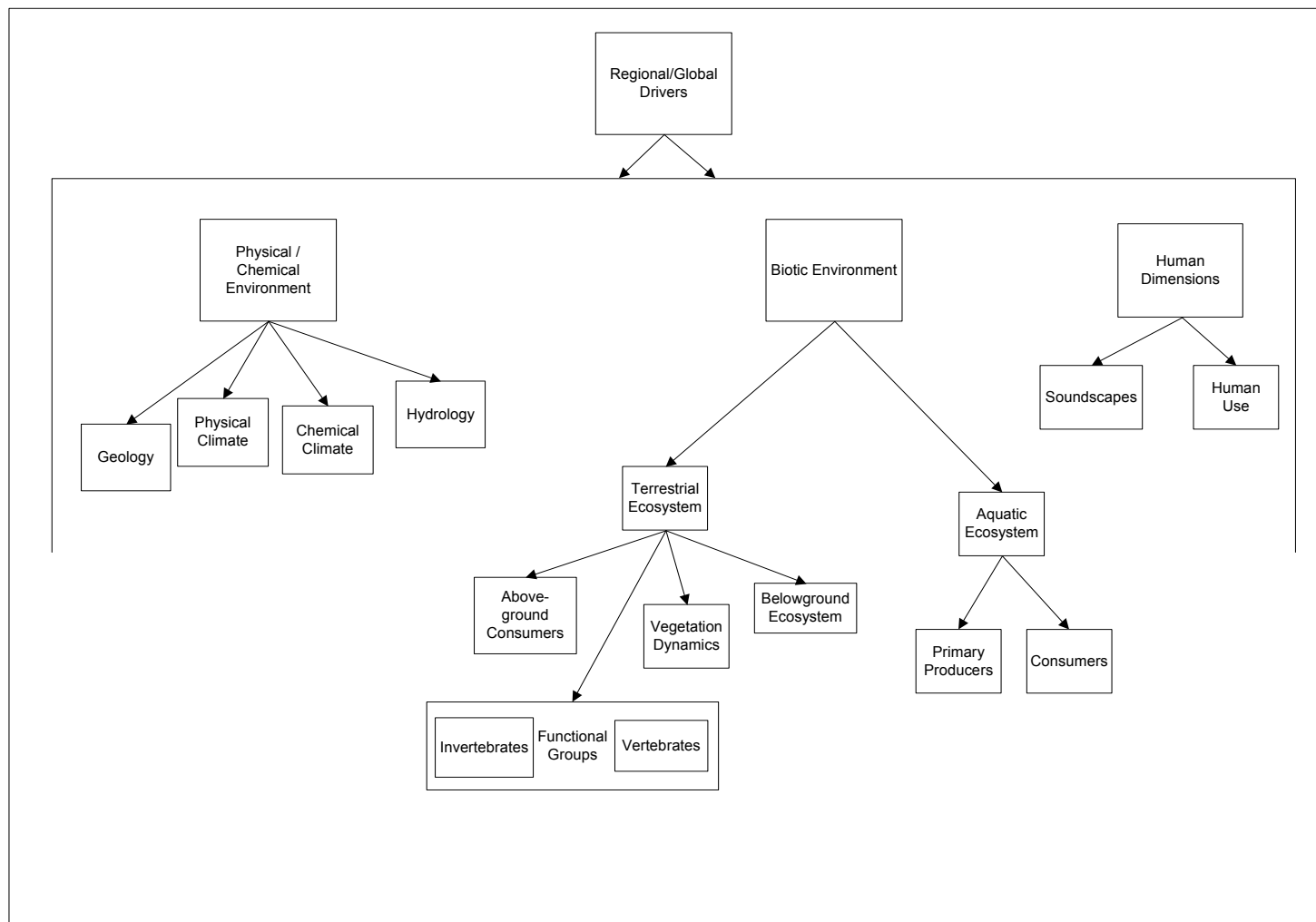


Figure III.4: Integration of vital signs showing among physical and chemical, biological, and human groupings (see Table III. 5 for category hierarchy).

Table III.3: Technical Committee's recommended list of 44 vital signs for the GRYN. Reasons for vital sign selection are cataloged for each Network park, with a key listed at the bottom of the table.

Resource / ecosystem domain	Selected vital signs	BICA	GRLE	YELL
Aquatic	Watershed budgets	4	4	4
	Continuous water temperature	3	3	3
	Groundwater quantity and quality	4	4	4
	Reservoir elevation	2	2	
	River invertebrate assemblages	1.a.b	1.a.b	1.a.b
	Springs and seeps distribution and hydrology	1.a.b	1.a.b	1.a.b
	Stream flow	1.b	1.b	1.b
Aquatic Biotic	Water chemistry	1.a.b	1.a.b	1.a.b
	Algal species composition and biomass	4	4	4
	<i>E. coli (Escherichia coli)</i>	3		
	Exotic aquatic community structure and composition		1.a.b	1.a.b
Atmospheric	Native aquatic community structure, composition, stability and genetic integrity	3	3	3
	Atmospheric deposition of nitrogen, sulfur and all major anions and cations (including wet and dry deposition)	4	4	3
Climatic	Change in visibility deciviews	4	4	3
	Basic climatological measurements	1.b.c	1.b.c	1.b.c
	Glacial retreat or advance		3	
Geologic (geothermal)	Earthquake activity		2	2
	Geothermal feature abundance and distribution		3	3
	Geothermal water chemistry		4	4
	Heat flow / chloride flux		1.a.b	1.a.b
	Soil structure and stability (includes cryptogamic crusts)	4	4	4
	Stream sediment transport	4	4	4
Human	Land-use change and habitat fragmentation	1.a.b.c	1.a.b.c	1.a.b.c
	Levels of backcountry day use		2	2
	Levels of backcountry overnight use		2	2
	Oversnow vehicles emissions		2	2
	Soundscapes	4	2	2
Terrestrial Biotic	Visitor use levels	2	2	2
	Amphibian occurrence	1.b	1.b	1.b
	Beaver presence and distribution	4	3	2
	Browse effects on riparian woody vegetation	3	3	3
	Communities of concern (riparian, shrub-steppe, aspen, and alpine communities)	4	3	3
	Exotic plant species abundance and distribution	1.a.b	1.a.b	1.a.b
	Fire, fuels and carbon storage	3	3	3
	Forest insect and disease	4	3	2
	Land bird distribution and abundance	3	3	3
	Land-cover classification	3	3	3
	Large carnivore population distribution and abundance	3	3	3
	Meso carnivore population presence and distribution	3	3	3
	Native insect diversity and distribution in riparian and mesic meadows	4	4	4
	Selected sensitive bird species abundance, distribution, and productivity	2	2	2
	Ungulate population distribution and abundance	2	2	2
	Vertebrate diseases	4	3	3
	Whitebark pine decline		1.b	1.b

Basis of selection

1. Considered by TC as highest priority (top 11 vital signs) because they fit one of the following criteria:
 - a) basic, critical information needed to make decisions
 - b) information that helps the Network describe and understand the broader system
 - c) managerial-driven information needs (e.g., T&E or snowmobiles)
2. Vital signs for which at least a minimally acceptable monitoring program is in place.
3. Some work is being done; however, only *part* of the vital sign is being monitored or more work is necessary.
4. Very little work is being done; might need an inventory before a monitoring program can be developed.

evaluated during the Delphi and subsequent steps with the intent of identifying vital signs at a more-generalized level of detail. This was the origin of the endpoint-oriented discussion of vital signs reflected above in Figure 1 and below in the remainder of this chapter.

[It is important to note that a variety of alternative approaches to vital-sign evaluation were suggested by different participants during various stages of the workshop process. All of the suggested approaches had merit, but the group decided to proceed with the process as planned because of time constraints. Appendix A briefly addresses this and additional issues that arose during the workshop.]

Post-Workshop Follow-Up and Synthesis

After the April 2003 workshop, the NCPN ecologist engaged in a round of follow-up visits to parks. All NCPN parks were visited during May-June 2003 to identify park-specific monitoring needs and increase network familiarity with park resources and issues. Also during this period, network staff worked closely with the SCPN in developing unified conceptual-modeling approaches (see Appendix I); vital-signs frameworks (Figure 1; Tables 1 and 2); and inventory, assessment and monitoring protocols for springs, seeps, and hanging gardens.

Park visits, coordination with the SCPN, and a reconsideration of input received during various phases of the vital-signs evaluation process facilitated the reorganization of candidate attributes and measures retained after the April workshop. These relatively specific measures were synthesized and aggregated into a shorter list of endpoint-oriented vital-sign candidates that is broadly applicable across the NCPN (Table 4). This list subsequently was reviewed and accepted by park staff, and it served as the foundation for the development by NCPN and park staff of park-specific vital-sign tables presented in the following section. Potential measures associated with these vital signs are presented in Appendix B.

Table 4. Vital signs of broad applicability across the NCPN. List was derived from synthesis and aggregation of candidate measures retained following the April 2003 vital signs workshop (Appendix A). See Appendix B for potential measures associated with individual vital signs.

Vital-Sign Category	VITAL SIGN
Ecosystem characteristics	
Climatic conditions	Precipitation patterns
	Temperature patterns
	Wind patterns
Air quality	Atmospheric deposition
	Visibility
	Tropospheric ozone levels
Soil, water, and nutrient dynamics	Upland soil / site stability
	Upland hydrologic function
	Nutrient cycling
	Stream flow regime
	Stream / wetland hydrologic function
	Groundwater dynamics
Water quality	SEE WATER QUALITY SECTION

Table 4 continued.

Vital-Sign Category		VITAL SIGN
Disturbance regimes		Fire regimes
		Hillslope erosional processes
		Extreme climatic events
		Insect / disease outbreaks in forests and woodlands
Biotic integrity	Predominant plant communities	Status of predominant upland plant communities (particular communities of interest may vary among parks in relation to values, threats, and probability/consequences of change.)
	At-risk species or communities	Status of at-risk species – amphibian populations
		Status of at-risk species – bat populations
		Status of at-risk species – Mexican spotted owl populations
		Status of at-risk species – peregrine falcon populations
		Status of at-risk species – other TES vertebrate populations (spp. vary by park)
		Status of at-risk species – TES plant populations (spp. vary by park)
		Status of at-risk communities – riparian-obligate birds
		Status of at-risk communities – sagebrush-obligate birds
		Status of at-risk communities – pinyon-juniper-obligate birds
		Status of at-risk communities – native fish communities
		Status of at-risk communities – native grassland / meadow plant communities
		Status of at-risk communities – sagebrush shrubland / shrubsteppe plant communities
	Focal species or communities	Status of at-risk / focal communities – riparian / wetland plant communities
		Status of focal communities – biological soil crusts
		Status of focal communities – aquatic macroinvertebrates
		Status of focal communities – other aquatic communities (communities vary by park)
	Endemic species or unique communities	Status of focal / unique communities – spring, seep, & hanging-garden communities
		Status of rare / endemic plant populations (spp. vary by park)
		Status of other unique communities (communities vary by park)
Landscape-level patterns		Land cover
		Land use
		Land condition
		Park insularization
		Landscape fragmentation and connectivity
Other vital-sign categories		
Stressors		Park use by visitors
		Invasive exotic plants
		Invasive, exotic, and/or feral animals
		Occurrence patterns of novel diseases / pathogens
		Permitted consumptive / extractive activities on park lands
		Park administration and operations
		Changes in stream hydrologic regimes due to surface-water diversions
		Changes in stream hydrologic regimes due to large reservoirs
		Changes in groundwater hydrologic regimes due to groundwater extraction
		Adjacent / upstream land-use activities
		Non-compliant uses on park lands
Other natural resource values		Status of paleontological resources
		Status of natural night skies
		Status of natural soundscapes

NCPN Vital Signs (excluding water quality)

This section begins with a network-level overview and discussion of vital signs that have been identified and prioritized for NCPN parks. Following the network-level overview, park-specific vital signs are presented in greater detail. Park-specific discussions emphasize relationships of

Appendix B. Sample Measures Pertinent to Broadly Applicable Vital Signs

Prepared by:

Mark Miller, USGS-BRD

15 August 2003

Table B-1. Sample measures of vital signs that are broadly applicable across parks of the Northern Colorado Plateau Network. Narrowly applicable, park-specific vital signs (e.g., pertaining to particular at-risk species or unique ecosystems such as caves) are not included in this table. Table 5 and park-specific vital-signs tables (in main body of Phase II Report) indicate actual vital signs identified for each park. Measures used to monitor particular vital signs may vary both among and within individual parks depending on site- and scale-specific considerations.

Vital-sign category	VITAL SIGNS	Sample measures (measures vary in degree of specificity; those with potential applicability to multiple vital signs are indicated in bold type)
Ecosystem characteristics		
Climatic conditions	Precipitation patterns	Total daily precipitation
		Frequency, magnitude, and duration of precipitation events
		Form of precipitation (rain vs. snow)
	Air temperature patterns	Daily minimum and maximum air temperatures
	Wind patterns	Average wind velocity and direction
		Frequency, magnitude, duration, and directionality of wind events
Air quality	Atmospheric deposition	Nitrogen deposition
		Sulfur deposition
		Major cation & anion deposition
	Visibility	Atmospheric particulate concentrations
		Visual range
		Light extinction
		Deciview
	Tropospheric ozone levels	Atmospheric ozone concentrations
		Foliar characteristics of ozone-sensitive plants
		Physiological performance of ozone-sensitive plants

Table B-1 continued.

Vital-sign category	VITAL SIGNS	Sample measures (measures vary in degree of specificity; those with potential applicability to multiple vital signs are indicated in bold type)
Ecosystem characteristics		
Soil, water & nutrient dynamics	Upland soil / site stability	Spatial distribution & density of social trails
		Spatial distribution & density of trailing by large ungulates
		Spatial distribution & density of vehicular disturbances
		Spatial extent of soil disturbances associated with trailheads, campgrounds, and other high-use areas
		Number, spatial distribution, and spatial extent of backcountry campsites
		Cover of biological soil crusts by morphological group
		Cover and structure of live vegetation
		Soil aggregate stability (field index)
		Litter and rock cover
		Size of bare-ground patches
		Soil-surface height in relation to benchmark
		Soil accumulation behind silt fences or natural sediment traps
		Soil accumulation in dust traps
	Upland hydrologic function	Soil penetration resistance (compaction measure)
		Spatial distribution & density of social trails
		Spatial distribution & density of trailing by large ungulates
		Spatial distribution & density of vehicular disturbances
		Spatial extent of soil disturbances associated with trailheads, campgrounds, and other high-use areas
		Number, spatial distribution, and spatial extent of backcountry campsites
		Cover of biological soil crusts by morphological group
		Cover and structure of live vegetation
		Soil aggregate stability (field index)
		Litter and rock cover
		Size of bare-ground patches
		Soil-surface height in relation to benchmark
		Soil accumulation behind silt fences or natural sediment traps
	Nutrient cycling	Cover of biological soil crusts by morphological group
		Litter cover
		Size of bare-ground patches
		Cover of live vegetation
	Stream flow regime	Soil penetration resistance (compaction measure)
		Continuous stream flow / discharge (cfs or cms); stream hydrograph characteristics (e.g., flow duration curves)
		Number and duration of dry periods in streams and rivers
		Frequency and duration of flow in ephemeral and intermittent channels

Table B-1 continued.

Vital-sign category	VITAL SIGNS	Sample measures (measures vary in degree of specificity; those with potential applicability to multiple vital signs are indicated in bold type)
Ecosystem characteristics		
Soil, water & nutrient dynamics	Stream / wetland hydrologic function	Areal extent of riparian / wetland vegetation
		Composition, structure, and vigor of riparian / wetland plant communities
		Stream channel morphology – surveyed cross sections
		Spatial distribution and size of sediment deposits / sandy beaches along major rivers
		Stream sediment load
		Spatial distribution & density of social trails in riparian / wetland zones
		Spatial distribution & density of trailing by large ungulates in riparian / wetland zones
		Spatial distribution & density of vehicular disturbances in riparian / wetland zones
	Groundwater dynamics	Soil penetration resistance (compaction measure) in riparian / wetland zones
		Water quantity (flow / discharge) at seeps, springs, hanging gardens
		Areal extent of wet soil / substrate associated with seeps, springs, hanging gardens
		Water-table elevation in relation to ground-surface elevations along ephemeral stream reaches
		Groundwater depth in wells pertinent to park groundwater recharge (small, regional aquifers)
		Areal extent of groundwater-dependent vegetation
		Composition, structure, vigor of groundwater-dependent plant communities
Water quality	SEE WATER QUALITY SECTION	
Disturbance regimes	Fire regimes	Fire occurrence on park lands – frequency, spatial distribution / extent, intensity, and timing
		Fire management activities on park lands – spatial distribution and timing by type of activity
		Spatial distribution and relative proportion of park lands in different “fire regime current-condition classes”
		Spatial distribution / continuity and proportional cover of fine surface fuels (differentiated by native & exotic vegetation)
		Spatial distribution / continuity of fuel types
	Hillslope erosional processes	Changes in slope profile in relation to benchmark
		Rate of slope retreat in relation to benchmark
	Extreme climatic events	Total daily precipitation
		Frequency, magnitude, and duration of precipitation events
		Frequency, magnitude, duration, and directionality of wind events
		Continuous stream flow / discharge (cfs or cms); flow events described by magnitude, frequency, timing, duration, and rate of change
		Distribution / extent and abundance of standing dead trees in woodland / forest ecosystems

Table B-1 continued.

Vital-sign category		VITAL SIGNS	Sample measures (measures vary in degree of specificity; those with potential applicability to multiple vital signs are indicated in bold type)
Ecosystem characteristics			
Disturbance regimes		Extreme climatic events	Distribution / extent and abundance of diseased / stressed trees in woodland / forest ecosystems
		Insect / disease outbreaks in forests and woodlands	Distribution / extent and abundance of standing dead trees in woodland / forest ecosystems
			Distribution / extent and abundance of diseased / stressed trees in woodland / forest ecosystems
Biotic integrity	Predominant plant communities	Status of predominant upland plant communities (particular communities of interest may vary among parks in relation to values, threats, and probability / consequences of change)	Composition and structure of predominant upland plant communities
	At-risk species or communities	Status of at-risk species – amphibian populations	Proportion of area occupied (PAO) Frequency of malformations
		Status of at-risk species – bat populations	Trends in key population parameters (e.g., colony size)
		Status of at-risk species – Mexican spotted owl populations	Territory occupancy Productivity
		Status of at-risk species – peregrine falcon populations	Territory occupancy Productivity
		Status of at-risk species – other TES vertebrate populations (species vary by park)	Potential measures vary by species
		Status of at-risk species – TES plant populations (species vary by park)	Potential measures vary by species
		Status of at-risk communities – riparian-obligate birds	Abundance and diversity of riparian-obligate birds
		Status of at-risk communities – sagebrush-obligate birds	Abundance and diversity of sagebrush-obligate birds
		Status of at-risk communities – pinyon-juniper-obligate birds	Abundance and diversity of pinyon-juniper obligate birds
		Status of at-risk communities – native fish communities	Abundance and diversity of native fish communities

Table B-1 continued.

Vital-sign category		VITAL SIGNS	Sample measures (measures vary in degree of specificity; those with potential applicability to multiple vital signs are indicated in bold type)
Ecosystem characteristics			
Biotic integrity	At-risk species or communities	Status of at-risk communities – native grassland / meadow plant communities	Composition and structure of grassland / meadow plant communities
		Status of at-risk communities – sagebrush shrubland / shrubsteppe plant communities	Composition and structure of sagebrush shrubland / shrubsteppe plant communities
	Focal species or communities	Status of at-risk / focal communities – riparian / wetland plant communities	Composition, structure, and vigor of riparian / wetland plant communities
			Areal extent of riparian / wetland vegetation
		Status of focal communities – biological soil crusts	Composition and structure of biological soil crust communities (by morphological group)
		Status of focal communities – aquatic macroinvertebrates	Abundance and diversity of aquatic macroinvertebrates by functional group
	Endemic species or unique communities	Status of focal / unique communities – spring, seep, & hanging-garden communities	Areal extent of groundwater-dependent vegetation
			Abundance and diversity of obligate taxa
		Status of rare / endemic plant populations (species vary by park)	Potential measures may vary by species
		Status of other unique communities (communities vary by park)	Potential measures may vary by type of community
Landscape-level patterns		Land cover	Number, areal extent, and relative proportions of land-cover (ecosystem) types on park lands
			Spatial distribution and configuration of land-cover types on park lands
			Number, areal extent, and relative proportions of land-cover types on adjacent lands
		Land use	Spatial distribution and configuration of land-cover types on adjacent lands
			Number, areal extent, and relative proportions of land-use types on park lands
			Spatial distribution and configuration of land-use types on park lands
			Number, areal extent, and relative proportions of land-use types on adjacent lands
		Land condition	Spatial distribution and configuration of land-use types on adjacent lands
			Areal extent and relative proportions of park lands in different ecosystem-condition classes (defined by degree of departure from desired condition)
			Spatial distribution and configuration of ecosystem patches on park lands classified by ecosystem condition
	Areal extent and relative proportions of adjacent lands in different ecosystem-condition classes		

Table 14. Candidate vital signs for Sonoran Desert Network parks.

[illegible]

WORKGROUP	INDICATOR	CAGR	CHIR	CORO	FOBO	GICL	MOCA	ORPI	SAGU	TONT	TUMA	TUZI
<i>Land Use</i>	Land Use – Park Neighbors	X	X	X	X	X	X	X	X	X	X	X
	Potential Land Use – Park Neighbors	X	X	X	X	X	X	X	X	X	X	X
<i>Vegetation</i>												
	Vegetation Formations	X	X	X	X	X	X	X	X	X	X	X
	Community Composition (Perennials)	X	X	X	X	X	X	X	X	X	X	X
	Exotic Plants	X	X	X	X	X	X	X	X	X	X	X
	Disturbance Events	X	X	X	X	X	X	X	X	X	X	X
	Phenology	X	X	X	X	X	X	X	X	X	X	X
<i>Vertebrates</i>												
	Species Richness**	X	X	X	X	X	X	X	X	X	X	X
	Species Distribution**	X	X	X	X	X	X	X	X	X	X	X
<i>Human Dimensions</i>												
	Park Visitation	X	X	X	X	X	X	X	X	X	X	X
	Migrant Impacts - Trails		X	X	X			X				

* “as needed” refers to additional survey efforts following intense stochastic events (e.g., flooding, extreme drought).

** see table 16 and [Appendix K](#) for clarification.